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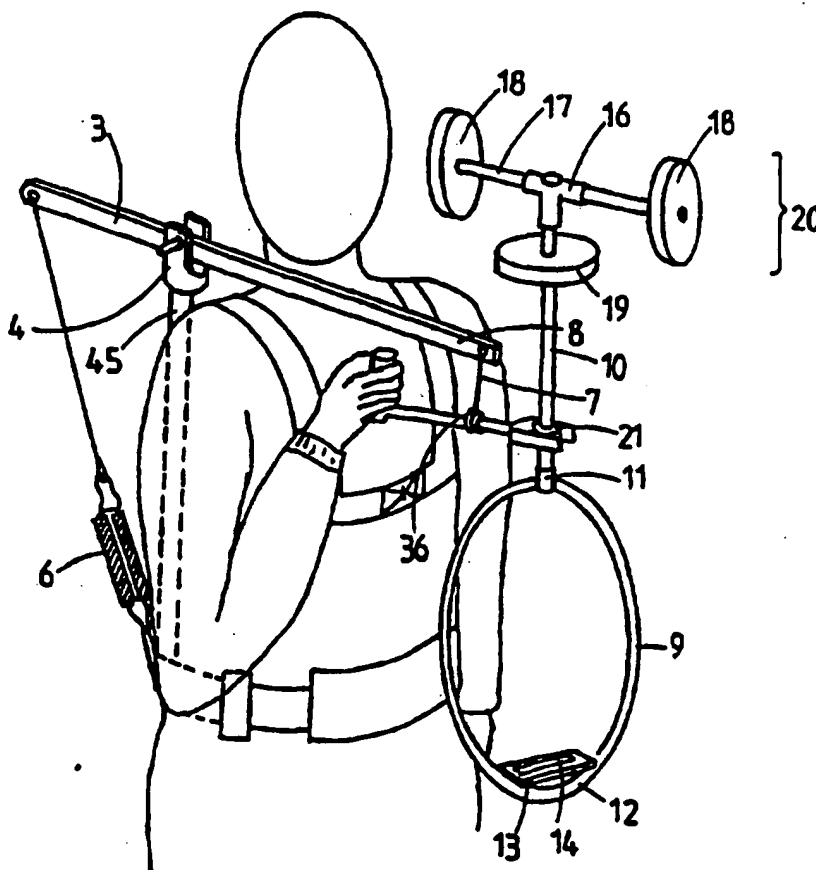
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(54) Title: BODY-MOUNTED STABILISING APPARATUS FOR A CAMERA

## (57) Abstract

A body-mountable stabilising apparatus for a camera adapted substantially to isolate the camera from unwanted movement caused by any motion of an operator using the apparatus comprising: a balanced camera mounting unit comprising a camera mount (13) connected by an elongate member (10) to a counterbalance means (20) and a first gimbal means (21) adjustably positioned on the elongate member (10) at substantially the centre of gravity and moment of inertia of the balanced camera mounting unit; a suspension arm (8) connected at a fulcrum point (4) to a support member (45) connected to or forming part of a body harness; tensioning means (6) interconnecting a rear end (3) of the suspension arm (8) to the body harness; and a connection means (7) connecting a front end of the suspension arm (8) to the balance camera mounting unit, substantially at its centre of gravity and movement of inertia; and wherein, in use, the balanced camera mounting unit is suspended in a substantially vertical disposition, a camera in the camera mount (13) positioned substantially directly above or beneath the counterbalance means (20) and the weight of the balanced camera mounting means with the camera mounted is transferred to the body of an operator.



## BODY-MOUNTED STABILISING APPARATUS FOR A CAMERA

### Technical Field

This invention relates to a body-mounted stabilising apparatus for a camera, in particular for video cameras and film cameras used in television broadcasting and cinematography.

### Background of Invention

Cameras used in the recording of moving subjects, whether in a broadcasting situation or in film production, often require the camera operator to move. Further, modern filming techniques often require camera-operators to move in relation to a fixed object or scene. In such situations it is generally necessary to provide the camera operator with a system which essentially isolates unwanted movements of the operator from the camera itself. Such systems have two primary functions: isolation of the operator's movement from the camera; and shifting the load of the camera and associated equipment from the operator's hands and arms to their body.

A variety of body-mounted support devices for motion picture cameras have been developed and used to date. The majority of these involve a balanced camera mounting unit interconnected at a gimbal mechanism to an articulated arm, the other end of which is affixed to the front of a body harness or belt.

For example, US 4,017,168 describes a camera and associated equipment mounted in exploded balanced relation about a handle, and a pair of interconnected spring loaded arms, one end of the arms being pivotally supported at the front

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shoulder of a carrying brace of a camera operator whilst the other end is connected to the handle position of the balanced camera unit. The handle is positioned at approximately the centre of the moment of inertia of the balanced camera unit. It will be appreciated that the weight of the equipment in this device is essentially transmitted to the front of the operator's shoulder, placing an uncomfortable strain on the operator's back. Further, the articulated arm system is designed to maintain the balanced camera unit in a particular point in space irrespective of the operator's movements. The inertia forces produced as a result tend to make it difficult for an operator to move the camera accurately with one hand.

Subsequently the inventors of US 4,017,168 developed an alternative articulated arm system which could be connected to the front of a waist band of an operator. This articulated arm is disclosed in US 4,394,075. US 4,158,490 and US 4,158,489 also discloses an articulated arm system connected to the front of a waist band of a body harness. Because the weight of these systems is again transferred to the front of the operator's body they can be uncomfortable and hard work to use for prolonged periods. Operator's are required to brace themselves by leaning backwards placing inordinate strain on the lower back.

US 4,474,439 discloses a modified version of a balanced camera mounting unit used with an articulated arm system. This patent discloses an inverted configuration in which the camera is positioned below the counterbalance.

US 4,206,983 discloses an alternative form of body-mounted stabilising apparatus for a camera in which a camera carrying assembly is suspended from a support arm passing over an operator's shoulder. The support arm is attached to a harness on the operator's back. This system incorporates a counter balancing spring means for the camera carrying assembly suspended from the forward end of a support member.

It also incorporates a tensioned cable carried from the body mount at the rear of the operator, via the support member, to the camera carrying assembly for suspending the assembly and for providing relative vertical movement of the camera carrying assembly relative to the support member. The camera carrying assembly is horizontally disposed and is controlled by the operator with both hands, one at each end of the horizontally disposed camera carrying assembly. This configuration, requiring double-handed control, prevents the operator from conducting any other required tasks, and also restricts the operator's ability to move quickly.

In addition, the horizontal configuration of the camera carrying assembly of US 4,206,983 restricts the extent of a pan operation, the body of the operator interfering with the pan of the horizontal assembly. Similarly, roll of the horizontal assembly is also restricted to  $\pm 45^\circ$  from the normal horizontal position.

It is also a characteristic of currently available body-mounted camera stabilising apparatus that they are complex to produce and therefore expensive. For example, US 4,017,168, US 4,394,075 and US 4,158,490 all incorporate sophisticated articulated arm systems, whilst US 4,206,983 incorporates a sophisticated harness and tensioned cabling system, and a dual-handed horizontal camera carrying assembly incorporating a central monitor.

Thus, it is an object of the present invention to provide a body-mounted stabilising apparatus for a camera in which tension and strain on an operator's body is reduced and which enables essentially single-handed control and stabilised movement of the camera in panning, tilting and rolling, and which therefore reduces the abovementioned problems, or which at least provides the public with a useful alternative.

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It is a further object of the present invention to provide a body-mounted stabilising apparatus for a camera which is convenient and easy for an operator to put on and use, and relatively inexpensive to produce.

#### Disclosure of the Invention

According to one aspect of the present invention there is provided a body-mountable stabilising apparatus for a camera adapted substantially to isolate the camera from unwanted movement caused by any motion of an operator using the apparatus comprising:

- a balanced camera mounting unit comprising a camera mount connected by an elongate member to a counterbalance means, and a first gimbal means adjustably positioned on the elongate member at substantially the centre of gravity and moment of inertia of the balanced camera mounting unit,
- a suspension arm connected at a fulcrum point to a support member connected to or forming part of a body harness,
- a tensioning means interconnecting a rear end of the suspension arm to the body harness, and
- a connection means connecting a front end of the suspension arm to the balanced camera mounting unit, substantially at its centre of gravity and moment of inertia,

and wherein, in use, the balanced camera mounting unit is suspended in a substantially vertical disposition, a camera in the camera mount positioned substantially directly above or beneath the counterbalance means, and the weight of the balanced camera mounting means with camera mounted is transferred to the body of an operator.

The balance of the camera mounting unit may be adjustable by two shuffle plates at one end of the stem, opposite the counterbalance. The shuffle plates may allow for two axis movement of the camera mounting plate (and hence camera) in relation to the elongate member and counterbalance, to balance the stem in the vertical.

In a preferred form of the invention the suspension arm may be pivotally and rotatably connected to the support member. This is preferably via a gimbal means with a three axis movement.

In one preferred form of the invention the gimbal means may allow pan, roll and tilt of the balanced camera mounting unit in relation to the suspension arm.

The counterbalance means may comprise an electronic viewing monitor which may be attached rotatably to the end of the elongate member. This allows the counterbalance to pivot and the operator to position the monitor in the best viewing position.

In a preferred form of the invention, the connection means may comprise a system of bearings one of which includes a pin on the forward end of the arm, the pin adapted to connect the elongate member and gimbal means to the suspension arm.

In a further preferred form of the invention the tensioning means may be adjusted to maintain the front end of the suspension arm at a desired height, thus requiring an operator to apply a small degree of pressure to hold the camera balanced mounting unit in equilibrium when the apparatus is in use.

Best Mode of Carrying out the Invention

Other aspects of the present invention will become apparent from the following description which is given by way of example only, and with reference to the accompanying drawings, in which:

- Figure 1: shows a perspective view of a body mounted stabilising apparatus for a camera of the present invention.
- Figure 2: shows a side view of the apparatus of figure 1.
- Figure 3: shows a view from above of the gimbal means and attached handle means of the balanced camera mounting unit.
- Figure 4: shows a perspective view of the support member for the suspension arm of the preferred form of the apparatus shown in figure 1.
- Figure 5: shows a schematic view from the rear of the tensioning means of the embodiment of the apparatus shown in figure 1.
- Figure 6: shows a side view of an alternative embodiment of the suspension arm incorporating a rigid connection means to the balanced camera mounting unit.
- Figure 7: shows a preferred form of fulcrum (block), rope, top gimbal, arm and back stem.
- Figure 8: shows a preferred form of balanced camera mounting unit.
- Figure 9: shows a preferred form of arm and harness.

According to one form of the invention shown in figure 2 there is provided a body-mounted stabilising apparatus 1 for a camera, comprising a balanced camera mounting unit 2, a suspension arm 3, a support member 4 attached to a body harness 5, a tensioning means 6 and a connection means 7 interconnecting a front end 8 of the suspension arm 3 with the balanced camera mounting unit 2.

The balanced camera mounting unit 2 comprises a ring 9 having an elongate member 10 affixed at one part 11 (for example by welding). At an opposite part 12 of the ring 9 is affixed a mount 13 for a camera. A camera mounted on a camera mounting plate (not shown) can be securely attached to the mount 13. The camera mounting plate is preferably adapted to allow the camera to slide forwards and backwards. The slot 14 in the mount 13 provides for lateral movement of the camera mounting plate. Thus, the weight positioning of the camera, can be adjusted laterally, forwards and backwards as necessary.

It will be appreciated that the ring 9 is only one of a variety of designs for the connection between the elongate member 10 and the mount 13. Other configurations are envisaged and may be employed without departing from the scope of the invention. A more preferred form is shown in Figure 8 and discussed later.

The end 15 of the elongate member 10 terminates in a block 16 in which the end 15 is held rotatably in place with a grub screw which can be adjusted to allow rotation of the block 16 as necessary. The block 16 also has a slot to receive a cross-member 17, substantially perpendicular to the elongate member 10. The cross-member is also held in position by an adjustable grub screw which may be released to slide the cross-member 17 within the block 16.

At either end of the cross-member 17 are masses 18. A third mass 19 is slidably engaged on elongate member 10.

Masses 18 and 19, block 16 and cross-member 17 form the counterbalance means 20. This counterbalance means 20 is adjustable to compensate for the type and position of camera mounted on the mount 13 in the following ways: each mass 18 is adjustable along the length of cross-member 17; the position of cross-member 17 in block 16 is adjustable; and the height of mass 19 on elongate member 10 is adjustable.

In an alternative embodiment the elongate member may be sleeved, the block and cross-member being attached to one end of an inner rod, telescopically engaged in the outer sleeve. In this configuration the whole balanced camera mounting unit may be expanded, providing a further means of adjustment.

Whilst the embodiment of the body-mounted stabilising apparatus 1 shown in the figures shows the counterbalance weights as masses 18, 19, it will be appreciated that the required counterbalance may be provided, in whole or part, by other optional electrical equipment such as batteries, an electronic pack and/or a monitor, as discussed below in relation to Figure 8.

Slidingly engaged on elongate member 10 (or on the outer sleeve thereof) there is also provided gimbal means 21. The position of the gimbal means 21 is adjustable on the elongate member 10 so that it may be positioned substantially at the centre of gravity and moment of inertia of the balanced camera mounting unit 2.

Referring to figure 3, the gimbal means 21 comprises a pan bearing 22 adjacent the elongate member 10, the pan bearing casing 23, a half ring 24 pivotally connected at either side 25, 26 of the pan bearing casing 23, for tilt control, and a gimbal tube 27 connected via cap screw 28 to the closed end 29 of the half ring 24. The gimbal tube 27 can rotate at its connection 30 on roll bearings 31. A grip 32 is connected

substantially perpendicular to the other end 33 of the gimbal tube 27. This grip 32 can freely rotate in relation to the gimbal tube 27. The gimbal tube 27 and grip 32 form a handle means allowing an operator to adjust the position of the balanced camera mounting unit 2 in space.

The position of gimbal means 21 on elongate member 10 is controlled by a clamping means, for example adjustable clamp rings.

The adjustability of all components of the balanced camera mounting unit 2 enables an operative to centre all moments of inertia on the gimbal means 21. By focusing the moment of inertia onto or fractionally below the pan bearing 23 on the elongate member 10, the impact of external forces on the camera through that bearing is minimised, or ideally negated.

Referring again to figure 2, the suspension arm 3 of the body-mounted stabilising apparatus 1 of the present invention comprises a length of rigid material (for example of aluminium) with a hole at one end 8 for attaching a length of thin but ultra strong rope 34 which forms the connection means 7 between the suspension arm 3 and the balanced camera mounting unit 2. The rope 34 may be kevlar, polyester or nylon based. At its balanced camera mounting unit end 35 the rope 34 is connected to the gimbal tube 27 via a bearing 36. The gimbal tube 27 can rotate freely in the bearing 36.

The length of the rope 34 must be short enough to enable an operator to adequately control the balanced camera mounting unit 2 via the handle means but long enough to provide substantial isolation of the balanced camera mounting unit 2 from the suspension arm 3.

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Figure 6 shows an alternative embodiment of the connection means between the suspension arm 3 and the balanced camera mounting unit 2. In this embodiment the suspension arm 3, which has pivot and pan capabilities through the support member 4, is effectively connected directly to the half ring 24 of the gimbal means 21 via the roll bearing 31. In such a configuration an operator can control the position in space of a camera on the camera mount by gripping the elongate member 10 above the gimbal means 21.

At the opposite end 37 of the suspension arm 3 a longer second piece of ultra strong rope 38 is affixed. This rope 38 connects the suspension arm 3 with two tension springs 39, which are in turn connected to a rear part 40 of a waist belt support means 48. It will be appreciated that the rope and spring system shown in the figures is only one example of an appropriate tensioning means for the suspension arm. Other forms of tensioning means are also envisaged.

The suspension arm 3 is pivotally connected to support member 4 between its ends 8, 37, the support member 4 forming a fulcrum point. Referring to figure 4, it can be seen that the support member 4 incorporates pan bearings 41 between a shaft 42 and the outer casing 43 which extends into a U-shaped element 54 into which the suspension arm 3 is pivotally connected. The suspension arm 3 may include several pivot points 44 which enable adjustment of the forward extension of the suspension arm for different operators.

In the embodiment shown in figures 1 and 2 the shaft 42 of the support member 4 is connected to support tube 45 which may be strapped to the back of an operator by a shoulder harness 46 attached to an upper part of the support tube and waist belt support means 48 attached to the lower end 47 of the support tube 45. It will be appreciated that the support member 4 may be attached to alternative forms of support systems. For

example, it is envisaged that the body harness 5 may incorporate a rigid or semi-rigid frame structure for distributing the load of the apparatus most comfortably on the back of an operator. Such a rigid or semi-rigid frame would incorporate an attachment means at an upper part thereof for the support member.

It is also envisaged that the attachment means of the harness, or the support tube 45, may be shaped to extend over the shoulder of a user to enable the support member 4 (and pivot point of the suspension arm) to be substantially above or slightly forward of an operator's shoulder. The benefits of such an adjustment are that the pan bearing 41 in the support member 4 would be free to pan without the suspension arm 3 interfering with the operator's head, and extension of the end 37 of the suspension arm 3 behind the operator would be minimised.

The rear part 40 of waist belt support means 48 is a covered or padded rigid or semi-rigid material adapted to distribute the load across the lower part of a user's back and hips. Ends 49 of the rear part 40 of the waist belt 48 have buckles 50 into which can be clipped ends 51 of the front part 52 of the waist belt support means 48. This front part 52 incorporates a panel of galvanised steel 53 padded on the inside and covered on the outside, to further distribute the load of the apparatus and to protect an operator's abdomen.

Use of the apparatus of the present invention will now be described.

An operator puts on and adjusts the harness 5, by adjusting the waist belt support means 48 and shoulder harness 46. In addition, the position of the suspension arm 3 on support member 4 may be adjusted.

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With the required camera mounted on the balanced camera mounting unit 2 the position of the gimbal means 21 and the components of the counterbalance means 20 are appropriately adjusted to ensure that the gimbal means 21 is essentially at the centre of gravity and moment of inertia of the balanced camera mounting unit 2.

The balanced camera mounting unit 2 is clipped onto rope 34 and the tensioning means 6 adjusted so that end 8 of the suspension arm 3 is pulled upwards. Equilibrium of the suspension arm 3 is therefore achieved by a small force exerted by the operator on the handle means. Since the weight of the balanced camera mounting unit 2 is transferred via the harness 5 to the back of the operator there is minimal stress on the hand and arm of the operator supporting the handle means.

With the gimbal tube 27, and therefore the balanced camera mounting unit 2, connected to the suspension arm 3 only by means of a rope 34, small movements of the support member 4 from left to right are not transmitted through the gimbal means 21 to the balanced camera mounting unit 2.

The operator can adjust the position of the balanced camera mounting unit in space by holding the grip of the handle means in one hand and applying sideways or vertical pressure on the gimbal tube to pan and/or tilt the suspension arm at its support member. In order to adjust the position of the camera itself the operator can grasp the elongate member 10 above the gimbal means 21. Panning is then achieved by twisting the elongate member, tilting by forwards or backwards pressure, and rolling by sideways pressure.

Figure 7 shows a preferred form of fulcrum (block) 55. As shown, the arm 56 is in a position as if it were under load and the camera mounting unit attached.

The three-axis gimbal 57 connects the arm 56 to the back stem or back support member 58. The arm 56 may be quickly detached from the gimbal 57 by means of a locking pin 59 or other suitable means, for storage. The pulley block 60 is made of steel / aluminium. However, any suitable strong, light material could be used such as, for example, carbon fibre. Either a sheave or ball bearing enables free running of the block under load.

A threaded rod 84 is provided in the lower end of the arm 56 to adjust the tension via a nut 85.

Figure 8 shows a preferred form of a balanced camera mounting unit 61. The camera is not shown. At the top end are two shuffle plates 62, 63, one arranged forward back, the other side to side. These can be locked off after balancing the camera and counterbalance (in this case a monitor 64) in the correct manner with the stem 65 vertical. Shuffle plate 63 (the smaller, bottom plate) is attached to the stem 65 directly. Shuffle plate 62 (the larger top plate) is adjustably attached to shuffle plate 63 through the two axes. Lock offs 73 are provided for the shuffle plates.

A gimbal and bearing system 66 is also attached to the vertical stem 65. The gimbal 66 forms the connection means to connect the camera mounting unit 61 with the suspension arm 56 (Figure 7). The gimbal 66 consists of a pan bearing 67 around the stem 65, tilt bearings 68 to the side, roll bearings 69 at 90° to the tilt bearings 68 and further pan bearings 70 below the roll bearings 69.

A pin 71 engages the pan bearings 70. The pin 71 is adapted to connect the gimbal 66 (the connection means 7) and stem 65 with the arm 56.

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The gimbal 66 is held by two slidably adjustable lock offs 72 comprising rings of metal. These lock offs 72 are easily adjustable to allow balancing of the counterbalance mounted camera at or near to equilibrium.

At the counterbalance end 84 of the stem 65, the counterbalance 64 is rotatably attached to the stem. This allows the operator to set a desirable viewing angle.

Figure 9 shows a preferred form of arm and harness. The arm 74 is not a straight piece of metal (such as aluminium) but comprises a couple of curved tubes 75, 76 at the top end 77. This terminates at a pin 71 to connect with the bearing means and gimbal 66 (see Figure 8). The opposite end 79 terminates at a three axis gimbal 57. Inside one of the tubes 76 runs a rope 82 and threaded rod 84. The rope 82 exits the tube 76 to run over the pulley block 60 and down to a tensioning means 83 (spring or springs), and is clipped onto the bottom of the back support member 58.

The threaded rod 84 terminates with the nut 85 resting on the rim of the tube through which the rope 82 and rod 84 run, thereby transferring the load.

The harness comprises foam cushioned braces 86 which extend over the operator's shoulders, around the midriff and waist whilst also providing support to the lumbar area of the operator's back.

A front waist pad 87 takes the majority of the load applied on the harness in a comfortable manner.

Where a monitor is required, the preferred form is a miniaturised remote monitor positioned directly in front of one eye of an operator. Alternatively, a conventional monitor may be incorporated in place of one or more of the weights on the counterbalance means.

Where additional electronics equipment is required it may be placed in a container or containers which may be attached to the counterbalance means in place of one or more of the weights. For example, a video sender unit for transmitting the image to a remote monitor, or a microwave unit enabling remote focusing, may be incorporated.

Although the invention has been described by way of example, and with particular reference to the preferred embodiments shown in the accompanying drawings, it should be appreciated that variations and modifications may be made thereto, without departing from the scope of the invention as defined above.

#### Industrial Applicability

The invention will find applicability in any field where video cameras and film cameras are used. In particular, the invention will be useful where films are being shot, and a moving camera may be desirable for the dynamics or intensity of the scene or event. The invention allows for such movement with fluidity and ease of use so as to enhance the production situation.

CLAIMS

1. A body-mountable stabilising apparatus for a camera adapted substantially to isolate the camera from unwanted movement caused by any motion of an operator using the apparatus comprising:
  - a balanced camera mounting unit comprising a camera mount connected by an elongate member to a counterbalance means, and a first gimbal means adjustably positioned on the elongate member at substantially the centre of gravity and moment of inertia of the balanced camera mounting unit,
  - a suspension arm connected at a fulcrum point to a support member connected to or forming part of a body harness,
  - a tensioning means interconnecting a rear end of the suspension arm to the body harness, and
  - a connection means connecting a front end of the suspension arm to the balanced camera mounting unit, substantially at its centre of gravity and moment of inertia,and wherein, in use, the balanced camera mounting unit is suspended in a substantially vertical disposition, a camera in the camera mount positioned substantially directly above or beneath the counterbalance means, and the weight of the balanced camera mounting means with camera mounted is transferred to the body of an operator.
2. A body-mountable stabilising apparatus as claimed in claim 1 in which the balance of the camera mounting unit is adjustable by two shuffle plates at one end of the elongate member.
3. A body-mountable stabilising apparatus as claimed in claim 2 in which the shuffle plates allow for two axis movement of the camera mounting plate in relation to the elongate member and counterbalance.

4. A body-mountable stabilising apparatus according to any preceding claim in which the camera mount is positioned substantially above the counterbalance means.

5. A body-mountable stabilising apparatus according to any preceding claim in which the suspension arm is pivotally and rotatably connected to the support member.

6. A body-mountable stabilising apparatus as claimed in any preceding claim in which the suspension arm is connected to the support member by a second gimbal means.

7. A body-mountable stabilising apparatus as claimed in claim 6 in which the second gimbal means has a three axis degree of movement.

8. A body-mountable stabilising apparatus as claimed in any preceding claim in which the first gimbal means allows pan, roll and tilt of the balanced camera mounting unit in relation to the suspension arm.

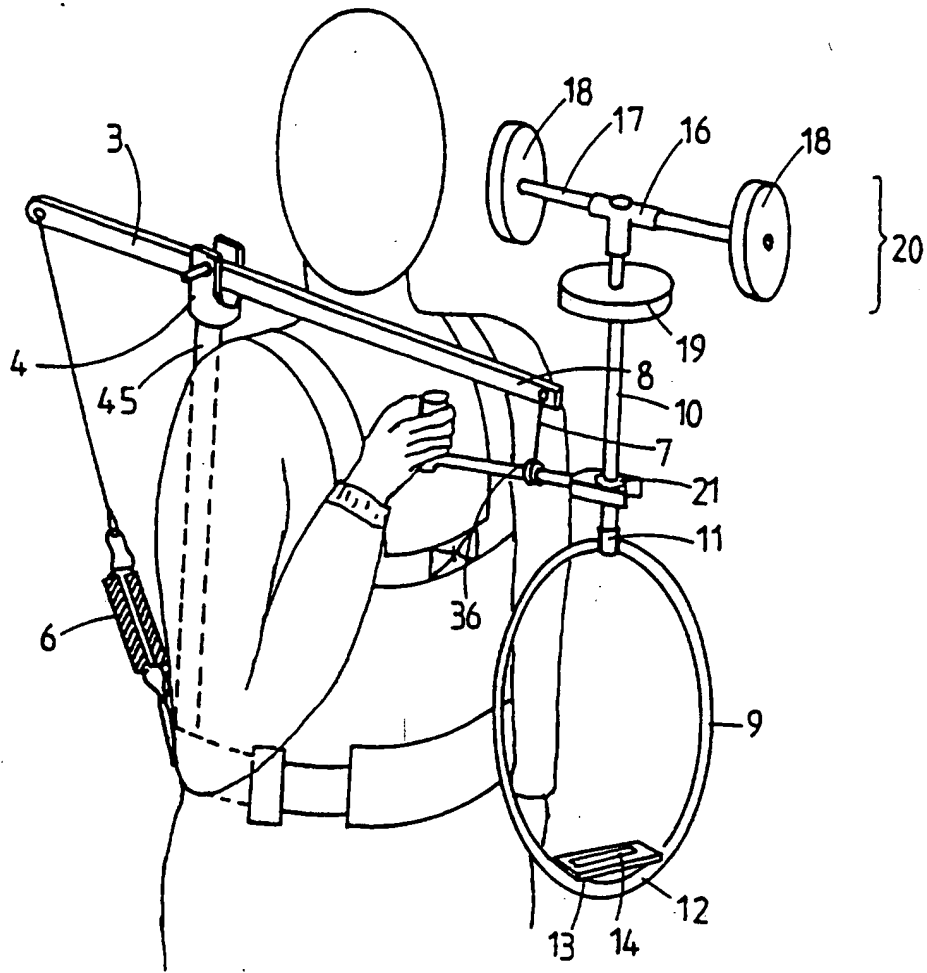
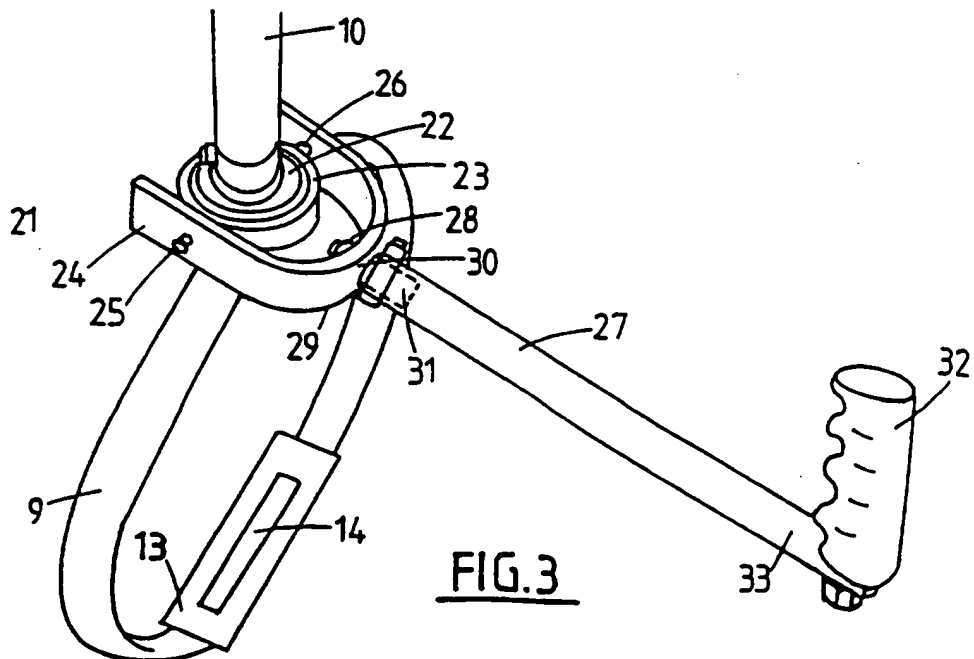
9. A body-mountable stabilising apparatus as claimed in any preceding claim in which the counterbalance means comprises an electronic viewing monitor.

10. A body-mountable stabilising apparatus as claimed in claim 9 in which the viewing monitor is attached rotatably and pivotally to the end of the elongate member, thus allowing the operator to position the monitor in the best viewing position.

11. A body-mountable stabilising apparatus as claimed in any preceding claim in which the connection means comprises a system of bearings, one of the bearings including a pin, and whereby the pin is adapted to connect the connection means and elongate member to the suspension arm.

12. A body-mountable stabilising apparatus as claimed in any preceding claim in which the tensioning means comprises a threaded rod in the lower end of the suspension arm, the threaded rod connected to a rope which exits the suspension arm and which passes over a pulley block at the fulcrum point and which runs down to connect with the tensioning means, the tensioning means comprising springs which are clipped onto the bottom of a back support member.

13. A body-mountable stabilising apparatus as claimed in any preceding claim in which the body harness comprises foam cushioned braces which are adapted to extend over an operator's shoulders, around the midriff and waist to thereby provide support to the lumbar area of the operator's back.

FIG. 1FIG. 3

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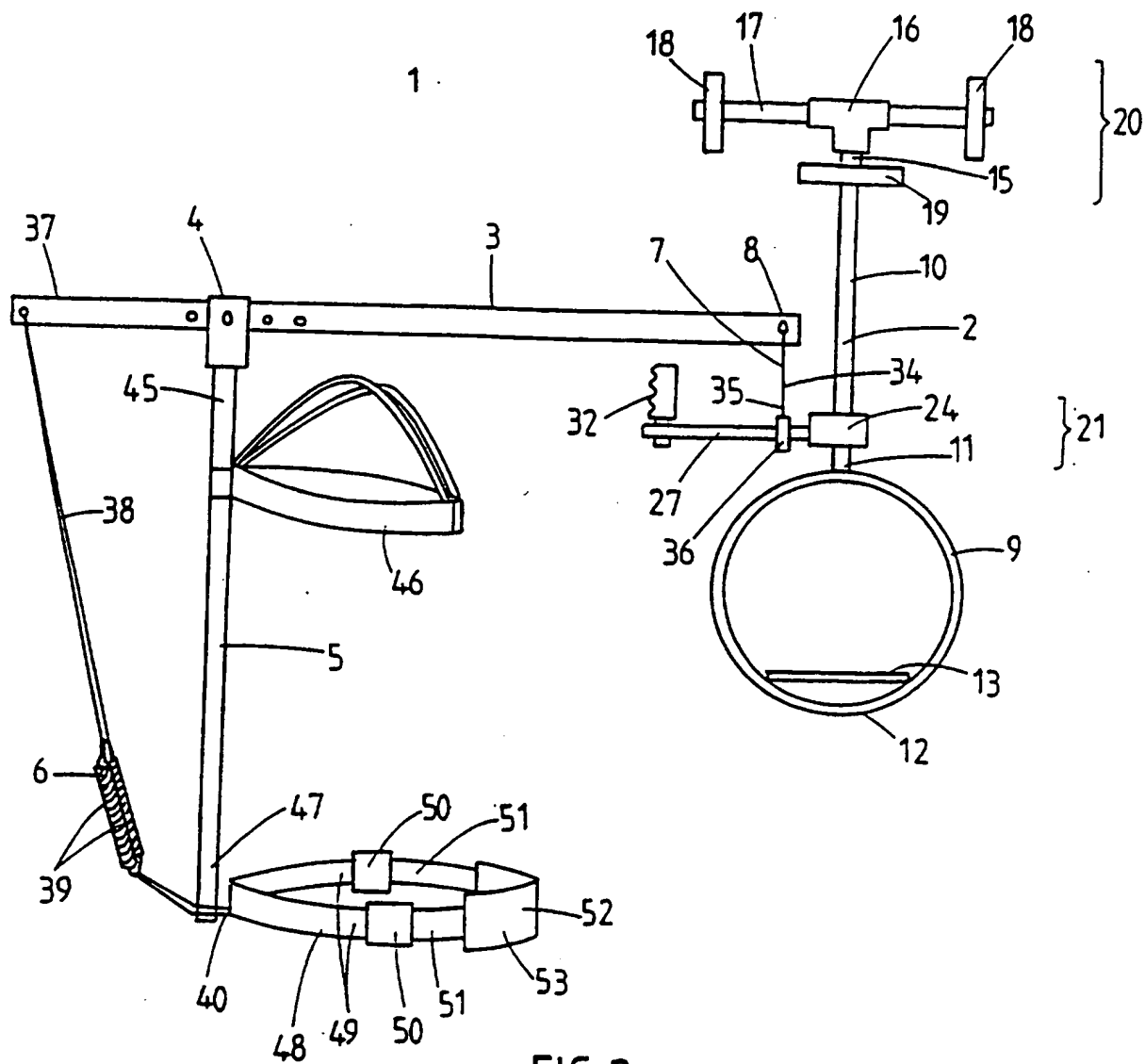


FIG. 2

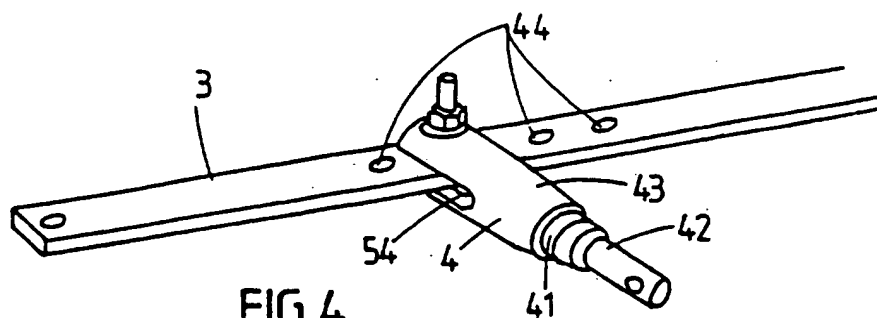


FIG. 4

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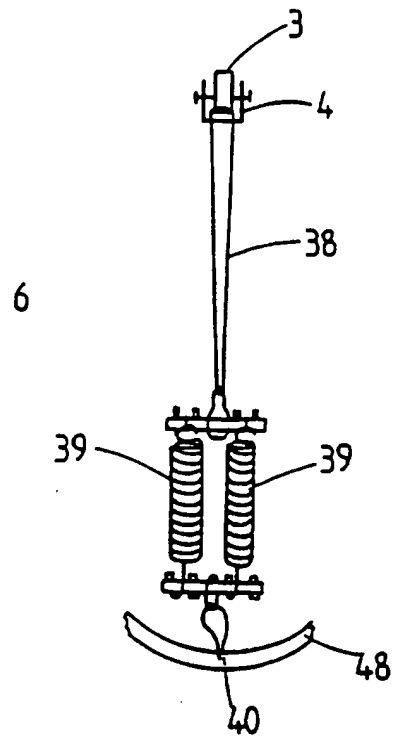


FIG. 5

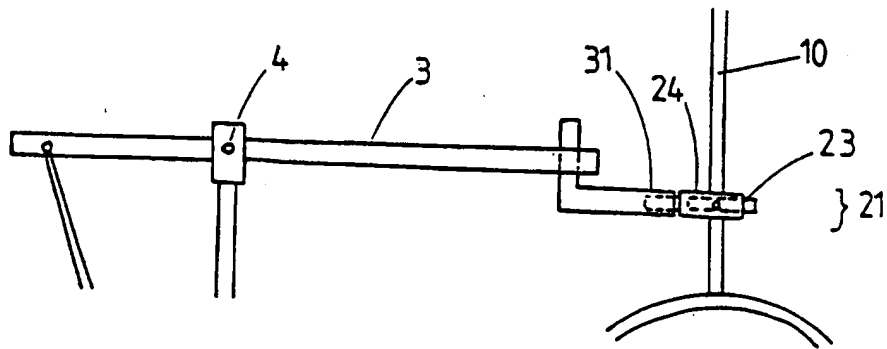


FIG. 6

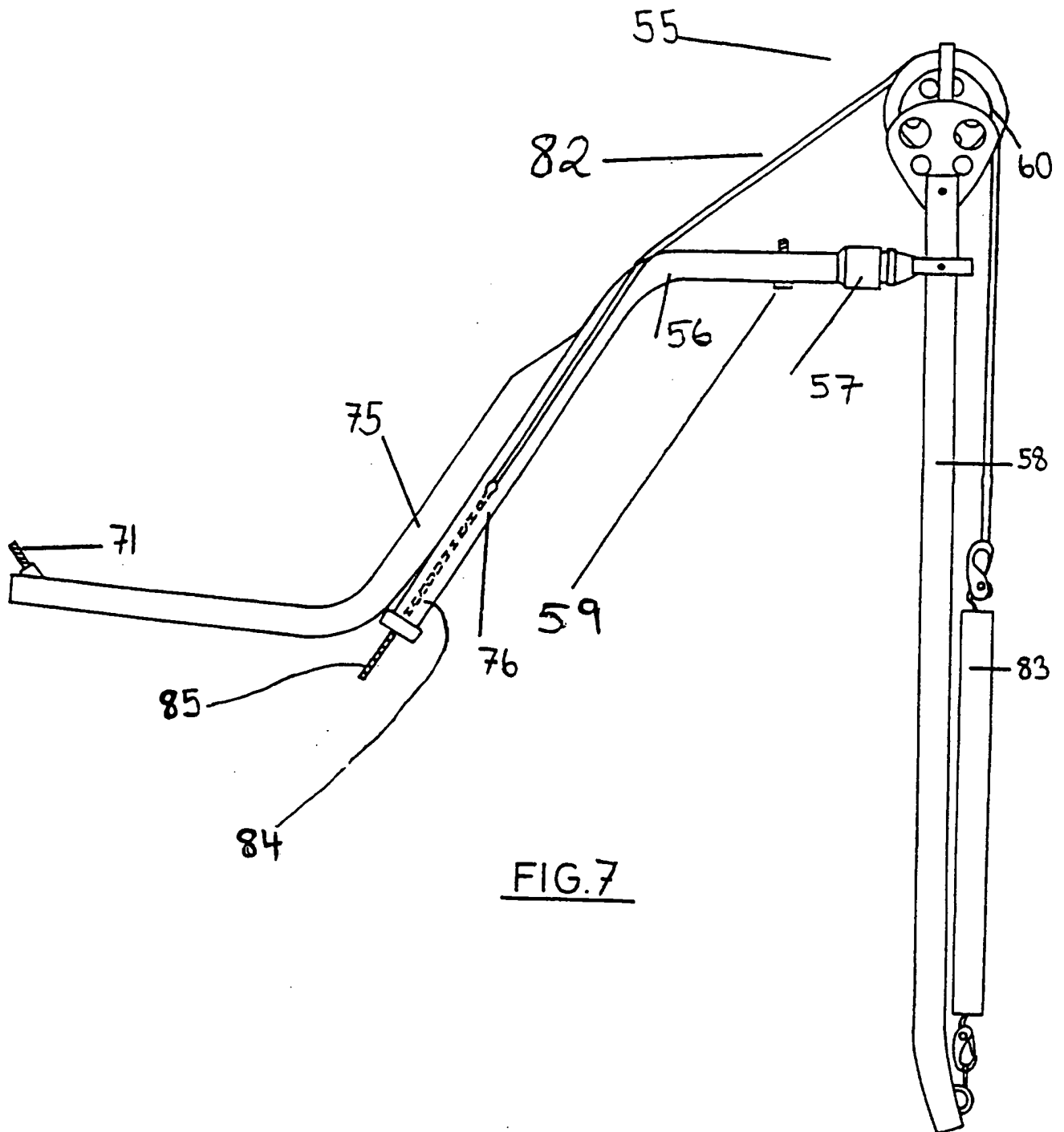
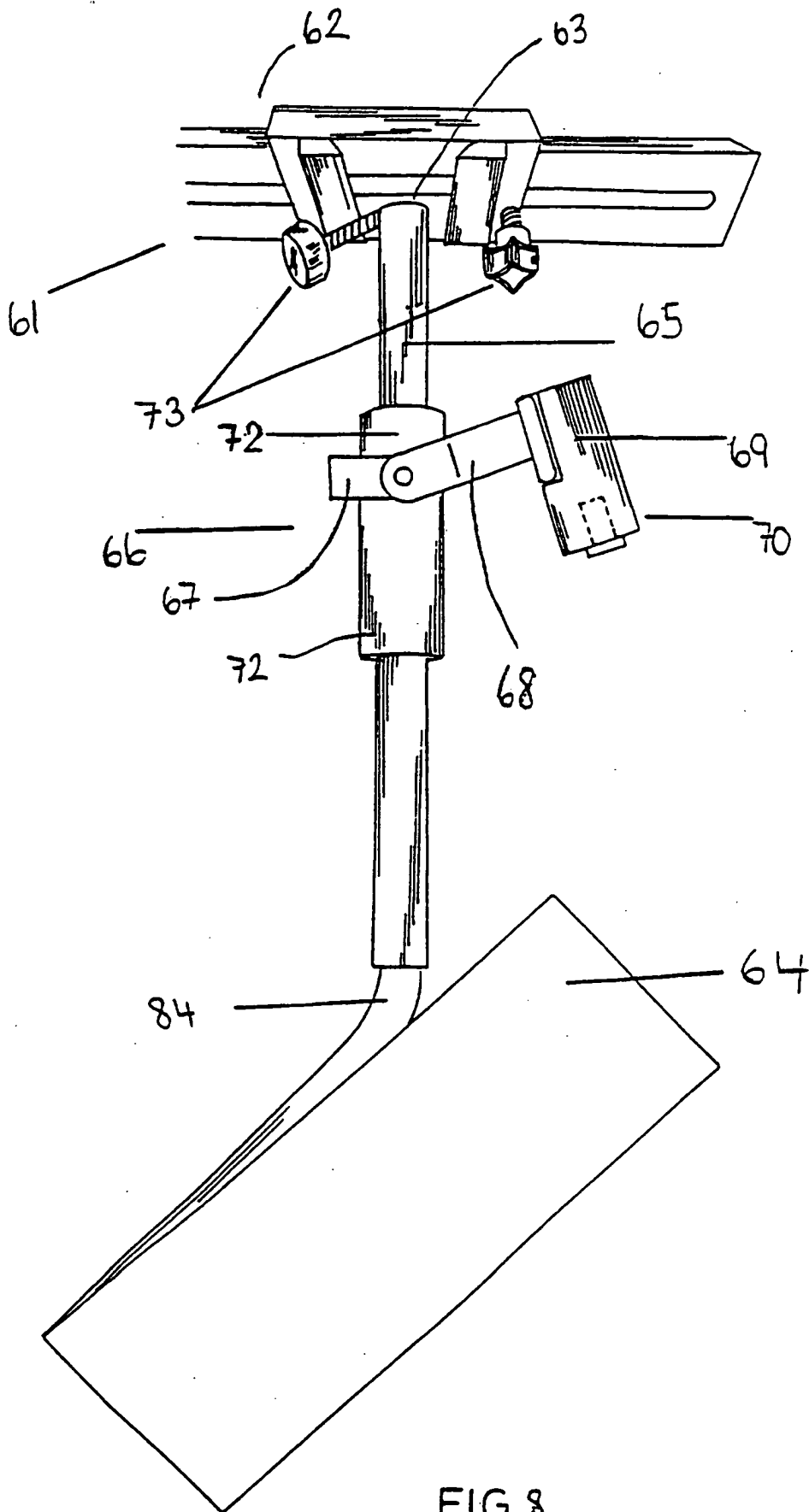


FIG. 7

FIG. 8

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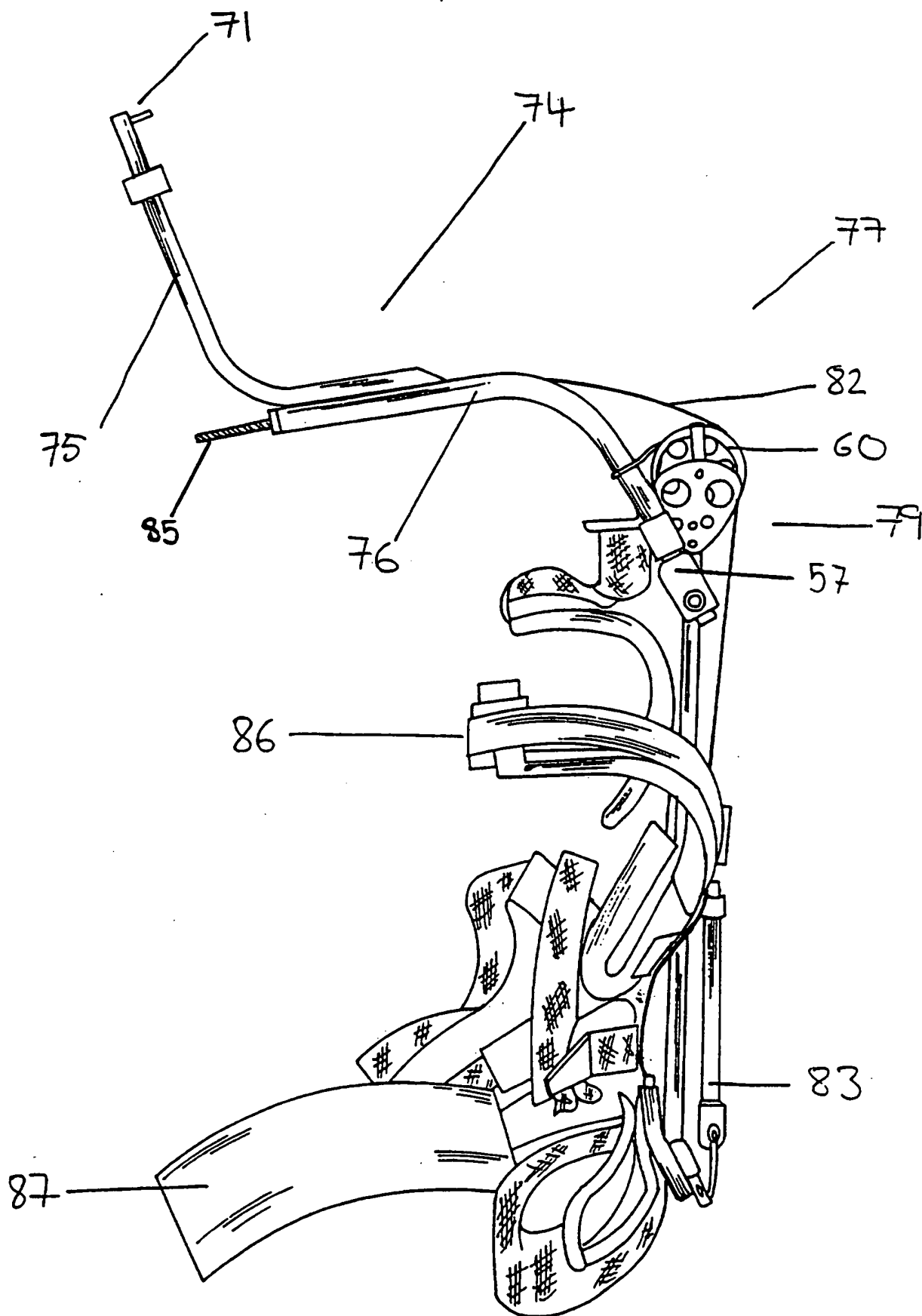


FIG 6